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TECHNICAL REPORT OR-02-86

MANAGEMENT, MAINTENANCE, AND UPKEEP OF THE BASELINE COMO III AIR DEFENSE MODEL

OCTOBER 1984 - SEPTEMBER 1985

BY

CHARLES E. COLVIN

20 OCTOBER 1986

U.S. ARMY MISSILE COMMAND

Redstone Arsenal, Alabama 35898-5000

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Technical Report OR-02-86
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:
4. TITLE (and Subtitle): Management, Maintenance, and Upkeep of the Baseline COMO III Air Defense Model October 1984 - September 1985.
5. TYPE OF REPORT & PERIOD COVERED: Final
6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): Charles E. Colvin
8. CONTRACT OR GRANT NUMBER(s): None
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Systems Analysis Division, Systems Analysis and Evaluation Office, U.S. Army Missile Command, Redstone Arsenal, AL 35898-5060
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
11. CONTROLLING OFFICE NAME AND ADDRESS: See 9 Above
12. REPORT DATE:
13. NUMBER OF PAGES:
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): See 9 Above
15. SECURITY CLASS. (of this report): UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report): None
18. SUPPLEMENTARY NOTES: None
19. KEY WORDS (Continue on reverse side if necessary and identify by block number):

Air Defense Simulation Methodology
Simulation Model Managment
COMO III Model Management

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report contains a review of all COMO Model Management and Maintenance efforts accompl'shed by the MICOM Como Model manager during the period of October 1984 - September 1985.

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SUMMARY

The purpose of this report is to provide a summary of all COMO model related efforts accomplished by the MICOM COMO Model manager during the timeframe of October 1984 - September 1985.

CONTENTS

I. INTRODUCTION

1. General

1.1 A MICOM COMO Model Management Board (CMMB) was established in May 1981 to ensure that this Command would continue to be responsive to both its own internal air defense analysis needs and external air defense analysis needs.

1.2 The CMMB, in late 1981, established and designated an ensemble of existing COMO software collectively referred to and known as the COMO III Baseline Air Defense Model (COMO). The baseline COMO III model consisted of the following software ensemble:

COMO Frame
COMO Runtape Assembly Program
PATRIOT Weapon Deck
HAWK Weapon Deck
CHAPARRAL Weapon Deck
STINGER Weapon Deck
ROLAND Weapon Deck
AIRCRAFT Weapon Deck
JAMMER Weapon Deck

1.3 The MICOM Systems Analysis and Evaluation Office (SA&EO) is a member of the CMMB and also serves as the MICOM COMO model manager. Some of the major responsibilities and duties of the COMO model manager include the following items:

a. Continuous implementation of the COMO Management plan.

b. Ensure adequate documentation of baseline software.

c. Day-to-day maintenance and upkeep of the baseline ensemble.

d. Provide COMO software to outside agencies/groups (Government and Contractors).

e. Develop and document new COMO software as required.

f. Provide COMO assistance to agencies desiring to use COMO for study purposes.

To accomplish the tasks required of the COMO model manager a support contract was awarded via competition for COMO model support; SRS Technologies was the winner of the support contract. COMO maintenance, management, and other types of efforts have been implemented by separate task work orders to the basic time and materiel (T&M) contract on an as-needed basis.

2. Purpose

2.1 The purpose of this report is to provide a compendium of all COMO related efforts accomplished by the COMO Model manager during the timeframe of October 84 - September 85. A synopsis will be provided for each effort which will provide a general idea and understanding of each effort.

II. GENERAL DISCUSSION

1. General

1.1 The COMO baseline software is maintained and operational on a CDC 7600, CYBER 74 and CDC 6600 mainframes in Huntsville, AL belonging to the Strategic Defense Command and the U.S. Army Missile Command. All of the COMO Modeling efforts contained and discussed in this report have been done under the guidelines of ensuring maximum compatibility with the UNIVAC 1100/82 mainframe at Ft. Leavenworth, KS. Thus making the task of implementation on the UNIVAC 1100/82 less time-consuming with minimal effort.

2. Specific COMO Tasks

2.1 General Maintenance and Upkeep

2.1.1 All simulation software, especially large-scale, force-on-force, "computerized wargaming" simulations, require continuous support, maintenance and upkeep. The entire COMO baseline ensemble represents over 32,000 lines of FORTRAN source code. With the COMO Model experiencing a high use-rate throughout the air defense community, it is readily apparent that unknown and unexpected coding errors and logic deficiencies will be detected and uncovered on a regular basis. Once found and fully understood, corrections to these errors/deficiencies are developed, tested, benchmarked and finally incorporated into the baseline software.

2.1.2 As studies are conducted utilizing COMO, accompanied by detail analysis of the land/air battle results, air defense analysts will recognize possible enhancements to specific areas of the software. Many times more efficient ways of accomplishing an air defense weapon system event, function or decision are discovered. Implementation of these enhancements and streamlining of the code (1) makes the software simulate specific weapon systems more realistically, (2) ensures compatibility throughout the totality of the ensemble, and (3) by increasing and improving logic efficiency computer execution time is speeded up along with requiring less main memory.

2.2 Merging of SETTER/QRADAR Weapon Deck with COMO Baseline Ensemble.

2.2.1 Future air defense study requirements identified by both the U.S. Army Air Defense Artillery School (USAADASCH) and MICOM elements indicated a need to merge the SETTER/QRADAR weapon deck with the baseline COMO ensemble. The SETTER/QRADAR weapon deck had been developed earlier by the Missile

Research Development and Engineering Center. The SETTER/QRADAR software was merged with the COMO ensemble. Incompatibilities were isolated and corrected and checkout runs made to ensure that the SETTER/QRADAR weapon deck would execute properly with the baseline ensemble.

2.2.2 A brief description of the SETTER weapon system and SETTER simulation model, both extracted from reference 1, are provided for general information.

2.2.3 The SETTER weapon system is a lightweight vehicle attended by two personnel; the vehicle driver and the weapon system operator. The vehicle contains multiple target sensor subsystems and two weapon subsystems. The sensor subsystems include passive, infrared (IR), television, and a nonimaging sensor and observer, typically the vehicle driver. Stinger missiles and hypervelocity rockets comprise the weapon subsystems. Weapon launchers and some of the sensors are integrated into a rotating turret controlled by the system operator. This turret is located on top of the vehicle. Spare weapons are carried in storage compartments within the vehicle and are manually retrieved when reloading is desired.

The SETTER mission is to thwart the advance of enemy troops and their support systems along a battlefront. The primary target of SETTER systems are helicopters and other low-altitude close support aircraft along the front. Lightly armored ground vehicles within the immediate vicinity of SETTER may also be engaged as targets by using the armor piercing hypervelocity rocket.

SETTER may be augmented by another sensor system, the Quiet Radar (QRADAR). The radar is considered quiet relative to attacking anti-radiation missiles (ARMs) whose objective is to knock out radars by homing on the transmitter. Thus, the radar's location is not easily discerned by ARMs. The QRADAR is located remotely from SETTER and one QRADAR may serve several SETTERs. There must always be a clear line of sight from the radar to each SETTER with which it is associated. On each rotational sweep the radar will transmit target information to the SETTER units that have been assigned to that radar.

The SETTER weapon system has several sensor subsystems which are presenting target data simultaneously and, of necessity, has a target assignment processor which correlates, prioritizes, and selects the single primary target. On the operator console the SETTER operator has a visual display indicating the current target. When an operator initiates a launch at the primary target, the target assignment processor will then present the next priority threat for disposition.

2.2.4 The SETTER simulation model is comprised of five COMO weapon decks:

SETTER
SETTER Track File Monitor
Missile flyout
QUADAR
QUADAR Track File Monitor

There are several interrelations between the models. The SETTER and QRADAR decks locate targets in accord with their sensor characteristics that are represented as track file entities. The SETTER and QRADAR track file monitor decks perform periodic updates to maintain an accurate state vector on the targets being tracked. The missile flyout deck performs flyout of the Stinger missile and contains the kill assessment logic for both Stinger and Spike (hypervelocity rocket) weapons.

Each SETTER unit in the game has a track file that represents the targets that have been detected. Each QRADAR in the game also has a track file that represents targets currently being tracked. A SETTER unit may be, but is not necessarily, linked with a single QRADAR. When this linkage exists it is established via COMIL input upon initiation of a simulation run. The linkage between a SETTER and a QRADAR enables the SETTER to access the track file belonging to the QRADAR thereby modeling real-world action of track data transfer from a QRADAR top an associated SETTER.

The SETTER model contains event routines modeling each of the several SETTER sensor subsystems. These sensor events are scheduled to operate asynchronously with respect to each other for a given SETTER unit. When one of the sensor models perceives there is a valid target which should be, but is not in track, then the event routine for that model causes a SETTER track file to be created to represent that target.

The target assignment function is represented in a distinct event routine within the SETTER model and operates periodically and independently of sensor subsystems activities. The target assignment activity models the real-world SETTER processor action to determine the highest priority target of current interest to the SETTER unit and then represents that preferred target as a visual image on the SETTER operator console. The target assignment logic within the simulation model peruses the track file for that SETTER and the track file for the QRADAR associated with the SETTER unit, if any, to construct a candidate target list. The target list contains one target from each of several target classes, if a target exists within that class, and is prioritized by target class. The target list will have null entries for the target classes that do not have a representative. The target assignment function will then schedule a target engagement sequence for only the highest priority target within the target list.

The target engagement sequence is composed of those decisions beginning with FLIR/TV lock on attempt and, in a successful firing sequence, culminating in a launch and intercept of the target.

The QRADAR operates autonomously with respect to all other simulated units. QRADAR periodically scans for targets and when it detects a target it creates a track file entry representing that target. Each QRADAR has exactly one track file in which target representations are stored. This

track file may be interrogated by any SETTER unit that is associated with the QRADAR unit. The QRADAR may drop track on a target if the target is acquired only on intermittent radar sweeps. The control values for maintaining and terminating track on a target are input via COMIL at initiation of the simulation run. Track file maintenance activities such as target state update, track termination, etc., are performed via periodic execution of the QRADAR track file monitor simulation model. If a QRADAR is killed during the course of a simulated battle, then all links with its associated SETTER units are severed and the units continue to operate autonomously.

A SETTER weapon deck functional overview of modeled events is shown in figure 1.

2.3 Incorporate the COPTR (U.S. helicopter) Weapon Deck into COMO Ensemble and Document COPTR Weapon Deck.

2.3.1 A weapon deck depicting an attack type helicopter firing TOW missiles was developed during the 1978-79 timeframe by TRW, Inc. under contract to the Army Missile and Space Intelligence Center. Various organizations (USAADASCH, MICOM, USAMSIC) utilized this weapon deck at various times adding different features as dictated by analysis needs. The COPTR weapon deck has been renamed the "HELICOPTER" weapon deck and brought under management and scrutiny of the CMMB. The HELICOPTER software has been merged with the baseline ensemble with no known, existing incompatibilities.

2.3.2 A brief description of the helicopter system and HELICOPTER weapon deck is given below. SRS Technologies developed a two-volume set of documentation for the weapon deck and is given in references 2 and 3.

2.3.3 Helicopter System - The helicopter system is capable of being equipped either as an attack vehicle or as an escort scout or troop carrier. The primary mission is to fly nap of the earth (NOE) in coordinated teams, attack SHORAD systems as necessary to get to and kill armored vehicles or other specially designated targets. Each team consists of a mix of attack helicopters (AHs) and scouts acting in dedicated or autonomous modes. Each active helicopter has a target detection and lock-on system (IR, EO, passive RF), communication equipment for intra-team coordination and target handovers, and a radar warning receiver for self protection. The AHs are equipped with a stock of command guided missiles that are either wire guided or laser designated.

2.3.4 HELICOPTER Weapon Deck Overview- Each Helicopter begins by flying NOE along a preplanned flight path in team formation or singly. When a dispersal point is reached, each helicopter departs to its assigned firing position. At the firing position, if the Helicopter is a LEADER, SCOUT, or operating autonomously, it ascends and begins searching for targets. Otherwise, it hovers in the down position waiting for a handover from a SCOUT.

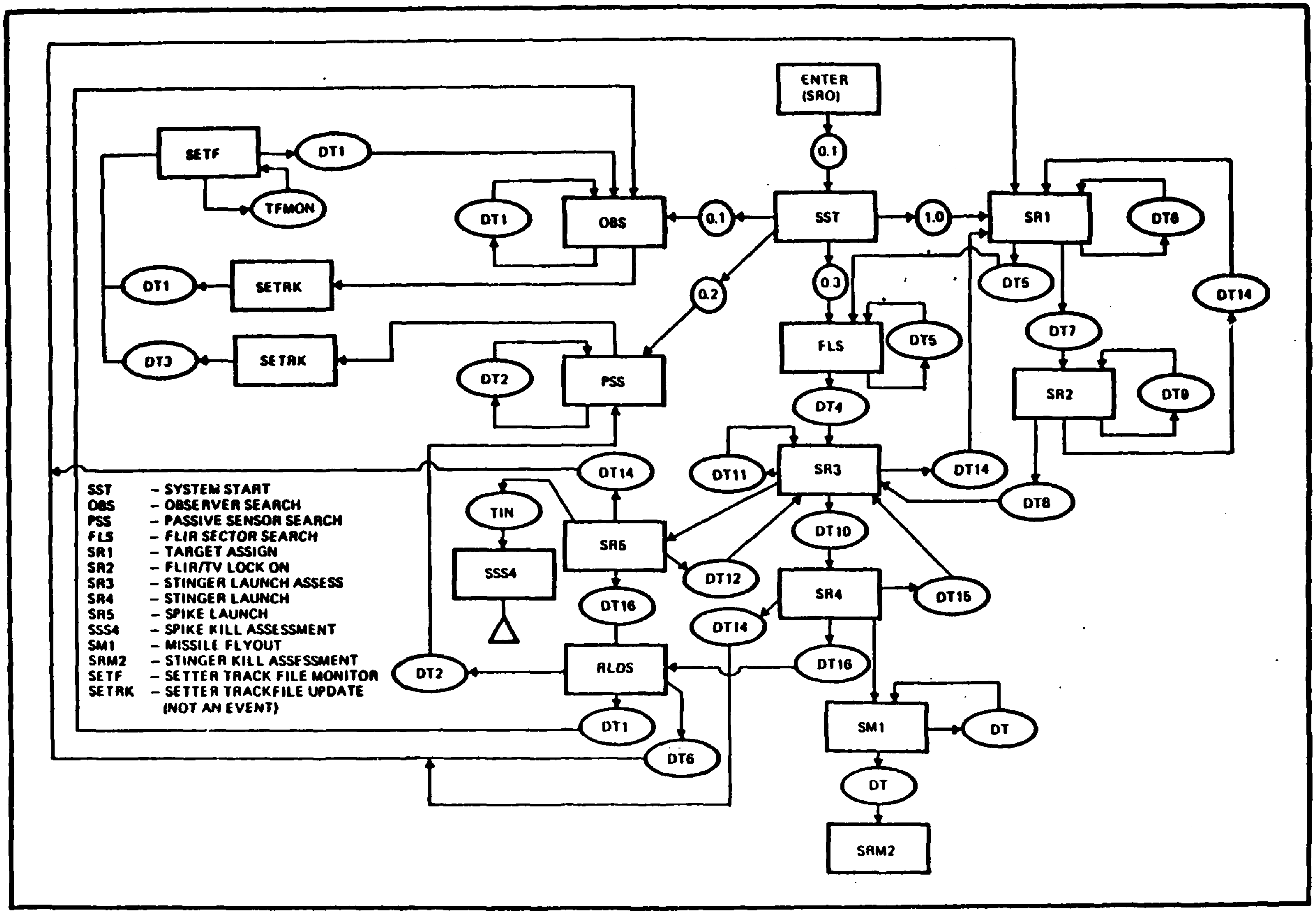


Figure 1. SETTER WEAPON DECK OVERVIEW

If the Helicopter is armed, it fires a guided missile when a target is detected. If it is a SCOUT, it hands over the detected target to the two (2) nearest idle attack helicopters. If it is a receiving helicopter, it ascends (if not already up) to acquire the target. Except when a missile is in flight, the helicopter descends immediately when it becomes apparent that it is locked-onto by the radar of an enemy air defense unit. After it has descended from the rise position, the Helicopter makes a lateral maneuver and ascends again to acquire another target.

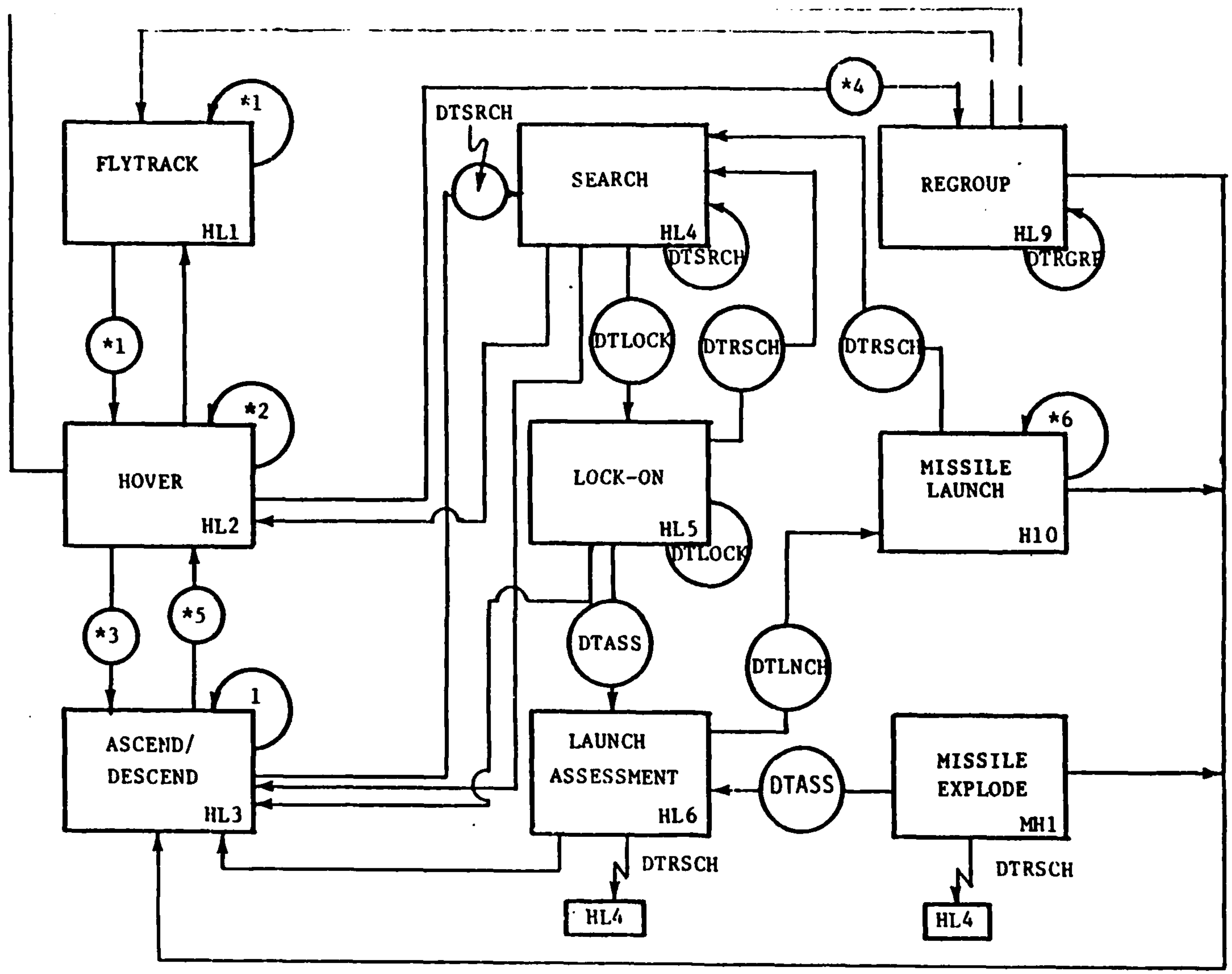
After exceeding the rise and fire limit, the Helicopter returns to NOE and proceeds to the regroup point to await the arrival of the rest of the formation. The Helicopter formation then flies the preplanned flight track to the next dispersal point for firing assignments or to the completed mission location (Go Home Point) in the rear area. Figure 2 is the functional flowchart for the events and delay times for the HELICOPTER weapon deck.

2.4 Documentation of E-SAM Weapon Deck

2.4.1 During the summer of 1983 the Systems Analysis Division of the Systems Analysis and Evaluation Office at MICOM sponsored the development of the Generic SHOMADS weapon deck for COMO III. The model development was done in response to a need for a Short Range, Medium Altitude Air Defense System (SHOMADS) identified by the U. S. Army Air Defense Artillery School (USAADASCH). SHOMADS was to resolve certain ADA deficiencies noted in the USAADASCH Mission Area Analysis and to provide an ADA system capable of operating with the Air Land and Close Combat Forces envisioned by TRADOC in the Air Land Battle 2000 concept. Initial indications showed a need for the SHOMAD weapon deck by early 1984 for use in a projected SHOMAD COEA. SHOMADS has been renamed the Evolutionary Surface-to-Air Missile System (E-SAM); thus we have now an E-SAM COMO Model. The model has been used with the PATRIOT, CHAPARRAL, and STINGER COMO III models for studying defense of Corps assets and in support of Rapid Deployment Forces. Several improvements were suggested during the model development period and the Systems Analysis Division sponsored three technical upgrades. Documentation produced by this effort includes all upgrades and enhancements contained in the E-SAM software, see references 4 and 5.

2.4.2 A brief E-SAM system description is given to provide a clearer picture of the system as modeled in COMO. E-SAM is envisioned as a replacement for the HAWK and CHAPARRAL systems as they are currently configured. As such it will be a Low to Medium Altitude system (LOMAD) used in support of maneuver forces and to provide point defense for high value/critical assets throughout the combat and communications zones. The system consists of four major components; the missile, the launcher, the tactical control element (TCE), and the acquisition sensor.

2.4.2.1 <u>The Missile</u> - The missile is to be mounted in a multiple-round cannister that functions both as a shipping and storage container and as



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WHERE $RR = SQRT\ (AMAX1(1., XR^2 + YR^2 + HR^2)$

$XR = XTRCK(I) - X(A)$

$YR = YTRCK(I) - Y(A)$

$HR = HTRCK(I) - H(A)$

*2: DTSTDN(A) OR DT FROM $6 MOVHEL

*3: 0 OR DTMXUP(A) OR DT + .1 (DT FROM $6 MOVHEL)

*4: DT FROM $6 MOVHEL

*5: (HMAX(A) - H(A))/(ASCRT(A))

*6: DTSLVO(A) OR DTLNCH(A)

FIGURE 2. HELICOPTER DECK OVERVIEW

a launch tube. It will be capable of vertical or near vertical launch. The missile will have on-board terminal guidance and be fire-and-forget or nearly fire-and-forget. The guidance system will provide for inertial guidance from the launcher prior to launch and the ability to select among on-board infrared (IR), radio frequency (RF), and passive RF (PRF) seeker systems after launch.

2.4.2.2 The Launcher - The launcher will be available in several configurations to permit deployment via C-130 and C-141 aircraft. It will mount 6 to 12 missiles and have an on-board sensor for target acquisition and tracking. It will be capable of receiving track data from other launchers, netted sensors, the TCE, and ADA command and control systems (i.e. SHORAD C^2, TSQ-73). The launcher must be able to provide track data to the missile before and after launch and have PJH, modulated RADAR/ADL, and tactical VHF-FM/HR-AM transceivers.

2.4.2.3 The Tactical Control Element (TCE) - The TCE exercises command and operational control over 3 to 6 launchers. It will receive the air-battle picture from its launchers, other TCEs sensors and the ADA C^2 system. It will provide applicable portions of this picture to its launchers and may provide command, control, and/or fire direction to the launcher sections.

2.4.2.4 The Sensor - The sensor must have a range and altitude capability which exceeds that of the missile. It must be able to acquire and track the target, point and lock the missile when the target is within seeker range, or guide the missile to within seeker range after missile launch. The sensor should be capable of acquiring and identifying tracks through more than one means and from non-cooperative targets. Track data must be able to be transmitted to the TCE and/or directly to the launcher.

2.4.2.5 Interoperability - E-SAM will operate in conjunction with and serve to complement the PATRIOT, STINGER, LADS, and SHORAD C^2 systems. It may be organized in separate battalions suitable for assignment to Corps ADA Brigades or ADA Brigades at echelon-above-corps (EAC) or a battery size unit may be incorporated with existing SHORAD Battalions.

2.4.3 Weapons Deck Overview

The COMO III Generic SHOMADS weapon deck models the E-SAM weapons system. It is divided into four modules. Each module simulates the functioning of one major system component. The modules are (1) Missile, (2) Launcher, (3) Sensor and, (4) TCE. The modules may be interfaced to model three operational modes. Autonomous launcher operations are simulated using the Launcher and Missile modules. The addition of the Sensor module provides for input of target track data from additional sources. The use of all four modules reflects autonomous operation at the platoon level with the TCE providing command, control, and fire direction to the launchers. At the present time, centralized fire direction/control by battery/battalion command echelons is not simulated by the weapon deck.

Initiation of a game results in a general sequence of events. Launchers, sensors and TCEs power up and establish communications as required by the scenario. Launchers and sensors begin acquisition. Track data is passed by the sensor to the launchers and/or TCEs and by the launcher to the TCE. The TCE passes correlated track data and fire control data to the launchers. The launcher provides target information to the missiles and engages targets assigned by the TCE or the highest priority target when acting autonomously. After launch, the launcher provides target update to the missile until the missile target seeker achieves lock-on. Once lock-on is achieved, the missile continues to intercept.

2.5 Assessment of different COMO Frames and COMO Runtape Assembly Programs.

The extensive use of COMO by different organizations since the middle to late 1970's has resulted with many different "versions" of the COMO frame and runtape assembly programs. COMO users had become concerned as to the differences between the versions and whether or not any user had a "better" version than anyone else. The COMO support contractor was tasked to perform an assessment of the COMO frames and runtape assembly programs listed below:

(a) MICOM Systems Analysis and Evaluation Office
- CDC 6600 @ MICOM
- CDC 7600 @ Advanced Research Center

(b) Research, Development and Engineering Center, MICOM
- CDC 6600 @ MICOM

(c) Missile and Space Intelligence Center (MSIC)
- CDC 7600 @ MSIC

(d) PATRIOT Project Office
- CDC 7600 @ Advanced Research Center

(e) U.S. Army Air Defense Artillery School, Ft. Bliss, TX
- CDC 7600 @ Advanced Research Center
- UNIVAC 1100/82 @ Ft. Leavenworth, KS

The contractor was also directed to make recommendations, based upon the assessment, on developing a MICOM standard frame and runtape assembly program. The assessment and recommendations were documented and are contained in reference 6.

2.5.1 Assessment Conclusions

The assessment showed, to the amazement of many, strong agreements within and between the different CDC frame and runtape assembly program versions.

2.6 Incorporation of TBM Weapon Deck into Baseline Ensemble

A tactical ballistic missile (TBM) COMO weapon deck was developed by the PATRIOT Project Office for analysis needs. This software allowed TBM types of threat to be included in the enemy raid against ground forces. This "small" weapon deck was incorporated into and made part of the COMO baseline ensemble of software.

2.7 Benchmarking the COMO III Baseline PATRIOT Weapon Deck with Simpler COMO Generic Models

The PATRIOT baseline weapon deck contains in excess of 5,500 lines of source code. A Simplified PATRIOT COMO III (SPAT) model was developed and documented in 1981 for use in PATRIOT studies not requiring the higher fidelity baseline model: SPAT has approximately 2,000 lines of source code.

The CMMB and other COMO users became interested in comparing the results of similar scenarios run on different PATRIOT COMO Models. A task was implemented with the COMO support contractor to access and evaluate the differences and similarities of results between the baseline PATRIOT model and the (1) SPAT, (2) CAA FOFEBA model and,(3) STC CIAD model utilizing the same tactical scenario in each case. The results of the effort are documented in reference 7.

2.7.1 Conclusions

Good comparisons for all four models were achieved over stylized one-on-one, one-on-few and few-on-many scenarios. This was somewhat unexpected due to large degree of fidelity between the four models. For the aggregated PATRIOT models (SPAT, STC CIAD, CAA FOFEBA) close detail must be paid to the model input parameters for PATRIOT. One would intuitively expect this since fewer input parameters implies less fidelity of the weapon system representation within the model.

2.8 COMO III Executive Level Documentation

A useful, clear and concise "executive level" level of documentation was needed for the COMO III baseline model. This level of documentation should present to the reader, in a non-technical format, basic facts and information relative to the COMO baseline model. The COMO support contractor was tasked to develop such a document and is contained in reference 8. The following major topics were included in the executive document:

(a) What is COMO III
(b) COMO III History
(c) COMO III Structure/Size of COMO III
(d) Users of COMO III
(e) Modeling of Key Air Defense/Threat Functions
(f) Existing COMO III Weapon Decks

(g) Brief Discussion of Baseline Weapon Decks
(h) Related Bibliography of Existing Documentation

2.9 COMO III FORTRAN IV - V Conversion/Validation

All CDC 7600 users at the Advanced Research Center were advised in late 1983 that FORTRAN IV would not be supported after November 1984. Based upon this fact, an effort was initiated with SRS Technologies to convert COMO III from FORTRAN IV to FORTRAN V. A significant effort was exerted in conducting verification/validation comparisons to ensure that the FORTRAN V code was behaving as the FORTRAN IV code.

2.10 SGT YORK Weapon Deck Enhancement/Documentation

A SGT YORK COMO III weapon deck had "evolved" during 1982 - 1984 with no one organization claiming to be the owner/originator of the software. With mounted interest of including the SGT YORK weapon system within the deployed ground forces, an effort was initiated by the CMMB to ensure adequate representation of the production version of SGT YORK within the COMO III weapon deck. Discussions and meetings were held with AMSAA, USAADASCH and the SGT YORK project manager during the enhancement phase to ensure that "all players" were aware and satisfied with any proposed change or addition. A SGT YORK user/analyst manual, see reference 9, was developed for the enhanced SGT YORK weapon deck.

2.10.1 A brief overview, extracted from reference 9, is provided for the SGT YORK COMO III weapon deck.

> The SGT YORK Gun weapon deck contains the seven critical events shown in Figure . DG1 is the surveillance radar event and contains the threat ordering logic performed by the fire control computer (FCC). It is initially scheduled from the enter game event (DG0) and is rescheduled on a cyclic basis. When radar target detection occurs, the optical search process (DG9) is terminated and the lock-on event (DG2) is scheduled with a time delay of DT12 seconds, which allows for turret slewing to the target azimuth plus one search cycle in elevation by the track radar/gunner's optics. DG1 constantly monitors the radar surveillance search volume and when a higher priority target is detected, initiates the necessary target replacement logic. DG1 will also monitor for jam strobes if normal target detections (range information available) are not made and will schedule DG2 if a jam strobe is detected.
>
> DG9 is the squad leader's optical search event. It is sector search centered around the gun's primary defense target line (PTL). The PTL and sector size are specified by COMIL INPUT. DG9 is initially scheduled when the fire unit enters the fame and is rescheduled cyclically as long as no targets are found by either the radar or optical systems. When a target is visually detected, DG9 schedules lock-on (DG2) after a reaction time.

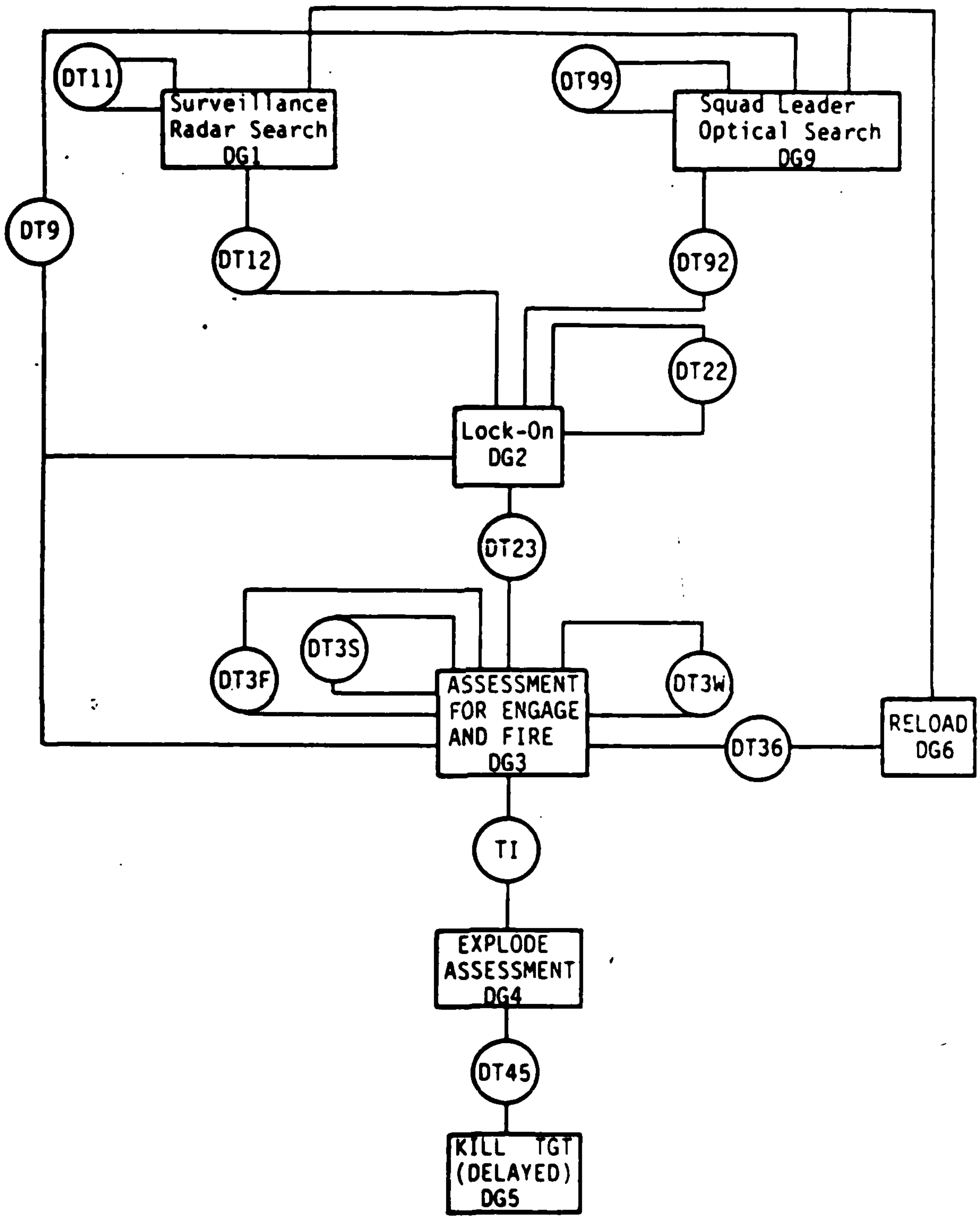

Figure 3. SGT YORK COMO III MODEL

DG2 is the lock-on event by either the track radar or the optical tracker (with range via the laser range finder). If lock-on is successful and target range is available, assessment/fire (DG3) is scheduled. Otherwise, DG2 reschedules as long as the target remains alive, visible, approaching, and lies within the engagement range of the system. The engagement is cancelled and the optical search event is re-initiated if any one of the above conditions are not met. Individual jam strobe tracks are only checked twice for track radar/optical lock-on before being dropped and having optical search re-initiated.

DG3 is the target assessment/fire event. A burst is fired at the target every DT3F seconds (variable dependent upon range and aircraft type) until a definite NO-GO assessment results or the gun ammunition supply is exhausted, at which time reload is scheduled. An independent combat unit (CU) is dynamically created for the burst in order to accommodate the limit of four events scheduled from any one CU at any one time.

DG4 is the explode event. In DG4 the kinematic constraints are checked and the random drew is compared to PKILL to determine the result of the engagement. If it is determined that the burst killed the target, DG5 will be scheduled after time delay of DT45 seconds to remove the target from the game. DT45 is the kill assessment time delay.

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1	AMSMI-OR (Mr. Risse')
2	AMSMI-RD-SS-AA (Dr. Jenkins)
1	AMCPM-AD-S (Mr. Sims)
1	AMCPM-HA-SE (Mr. Comer)
1	AMCPM-CF-E (Mr. Byrd)
1	AMCPM-ST-SE (Mr. Brothers)
1	AMCPM-PA-SE (Mr. Lavender)
1	Director, U.S. Army Missile and Space Intelligence Center, ATTN: AIAMS-YTI (Mr. Shepperd), Redstone Arsenal, AL 35898
	Commander, U.S. Air Force Operational and Test Evaluation Center, Kirkland AFB, NM 87117-7001
1	AFOTEC-CNN (Dr. Williams)
1	AFOTEC-OAN (Mr. McDonough)
1	Director, U.S. Army Concepts Analysis Agency, ATTN: CSCA-FSC (Mr. Rose), 8120 Woodmont Ave., Bethesda, MD 20814-2797
1	Commander, U.S. Army Materiel Command, ATTN: AMCDMA-MS (Dr. Lazaruk), 5001 Eisenhower Avenue, Alexandria, VA 22333-0001

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